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CONTENTS.

QUERY.

Can any reader of *Science* cite a case of lightning stroke in which the dissipation of a small conductor (one-sixteenth of an inch in diameter, say,) has failed to protect between two horizontal planes passing through its upper and lower ends respectively? Plenty of cases have been found which show that when the conductor is dissipated the building is not injured to the extent explained (for many of these see volumes of Philosophical Transactions at the time when lightning was attracting the attention of the Royal Society), but not an exception is yet known, al though this query has been published far and wide among electricians.

First inserted June 19, 1891. No response to date.

N. D. C. HODGES, 874 BROADWAY, N. Y.

SCIENCE

NEW YORK, SEPTEMBER 29, 1893.

THE MUTUAL RELATIONS OF SCIENCE AND STOCK BREEDING.*

BY WM. H. BREWER, NEW HAVEN, CONN.

THE production of crops and the production of animals are the two great branches of agriculture. The application of science to the production of crops has been more conspicuously before the public than to the production of animals, and agricultural science has devoted most attention to this branch of production. There could be no comprehensive science of agriculture until there was a science of chemistry, and the modern revolution in the art and practice of agriculture has come about as the science of chemistry advanced and mechanical invention progressed.

The application of scientific methods to the economic breeding of farm animals came much later and followed the publication of Darwin's "Origin of Species." Facts began to be systematically recorded for the construction of a science of breeding much earlier than that, but a collection of facts does not constitute a science, and breeding remained strictly an art until within the last few years.

As an art breeding attained a high standard long ago as respects the production of some fine examples of particular breeds. But except with Arabian horses, and possibly certain strains of game-fowls which were bred nearly pure, crossing was the universal method of improvement practised in all countries of European civilization. This led to wide variation and great uncertainty of product. The modern method of improvement within the breed, keeping the blood pure, has been the outcome of scientific study applied to the economic production of animals.

This knowledge was of slow growth and the practice was applied to the breeding of English race horses before it was to useful farm animals. The English race horse, or "Thoroughbred," is of composite origin, but originally mostly of Oriental stock. The pedigrees of the winners began to be printed before the middle of the last century, and after a time an annual list of the winning sires was published. It came to be recognized that the winners were, as a rule, of the purest blood, rather than crosses, and this led to improvement by selection within the breed itself rather than by crossing. Then pedigrees were gathered and collated and the first volume of the "Stud Book" was published in 1791. This gave the data necessary for a study of the ancestry of any given animal of that breed, but the method was not extended to the breeding of the other useful farm animals until long after, and more than thirty years elapsed before any other comprehensive registry of pedigrees was printed for public use. The "Shorthorn Herd Book" was published in 1822.

The forerunner of breeding by pedigree as now practised was breeding in-and-in, which came into use for farm animals the last quarter of the last century. This was the opposite extreme of the wide crossing, so widely practised, and Robert Bakewell was its greatest promotor. Beginning with a very few carefully selected animals, he grew his flocks and herds from them, breeding between the nearest of kin and thus restricting the ancestry as to numbers, but increasing enormously the potentiality and hereditary influence of certain superior animals. He practised with great skill and selected his breeding animals with rare sagacity. He wrought great improvement, refining the carcass, improving the form, and extending the change to early maturity, better quality of flesh and general improvement in useful qualities of the animals. He wrote nothing. Breeding was with him a secret art, practised with great skill and success. This art was, however, taught to certain of his pupils, of which the brothers Colling became famous as breeders of shorthorns. But there was no science recognized because the general laws were not understood. Even Colling introduced a cross into his herd, and breeders are still, after nearly a century, discussing the influence of that "Galloway cross" on the breed.

Most of the leading breeds of our farm animals existed after a fashion in the last century. The early history of nearly all of them is obscure, although much research has been expended in unraveling it. But, unless confined to some small island, as were the Jersey, Alderney and Guernsey cattle, the breeds were not kept pure, because the common method of improvement was by crossing with other blood. Uniformity could neither be secured nor maintained by such practice, and naturally all the economic results were highly uncertain.

Some animals of great excellence were produced, but they were the accidental result of the uncontrolled and uncontrollable variation incident to the methods of breeding then followed.

The twenty-five years during which Darwin was accumulating the material and digesting the facts for his "Origin of Species," were important ones in the history of the theory of breeding, and a number of pedigree records were begun publication. The doctrine of improvement by selection within the breed instead of crossing with other blood was becoming better and better known by the more successful breeders, and the economic results were becoming more and more certain.

But scientific naturalists, absorbed in the description of natural species, ignored man's artificial productions. A breed may be, and often is, as artificial a production as is a picture or a statue. The breeder, like the sculptor, must have his ideal towards which he is working, the greater his genius the nearer his creations come to reaching his ideal. The earlier naturalists, like Buffon and Cuvier, had studied and written about domestic animals as a part of nature, but their successors came to consider them artistic rather than natural productions, and to look upon these "artificial monstrosities" with a contempt not now appreciated by the younger generation of naturalists.

But the difficulties of the old system were well nigh crushing the life out of natural history, and the time was ripe for a new theory on the origin and nature of species.

*Synopsis of Address by Wm. H. Brewer, Vice President of Section I., American Association for the Advancement of Science, at Madison, Wisconsin, Aug. 17, 1893.

When Darwin brought us out of the difficulty it was largely by a study of the experience of breeders. This was analogous to the establishing of a new and vast biological laboratory for scientific experimentation and never before was such a profound change brought about in a dogma of science by a study of an economic art.

All the earlier stud books and herd books were prepared and published by private individuals as any other book might be produced by a compiler and author. Now they are mostly published by associations clothed with authority and having wider aims. They record and publish pedigree, define methods and conditions for establishing their authenticity, and fix the standards which dictate what the essential characters of the breeds shall be. Nearly every useful breed has now some such association, publishing an authorized stud book, herd book, flock book, or register of some kind; the total number of such works aggregates hundreds if not thousands of volumes.

It is in fancy breeding that the most wonderful results are produced and some of the most instructive facts are found. The economic factor is here often entirely eliminated, and mere whim or fancy guides the experiments. Fanciers had their associations and set their standards long before the breeders of the more useful farm animals did, and to that Darwin turned his attention. He joined various pigeon societies, put up his cotes, became a practical and experimental fancier and mingled with his fellow fanciers, drawing on their rich stock of knowledge and experience.

A result of all this has been a better knowledge of the laws of heredity and of the causes which promote variation. A science of breeding now underlies the practical art. A pure science is relatively exact in the proportion in which it enables us to predict events, its economic applications are valuable in the proportion in which it enables us to control results. The breeder of to-day controls results with a success his ancestors never dreamed of.

The practical result is that the economic production of animals is now placed on a very much surer foundation, excellence is made more uniform, the chances for failure are enormously lessened and the methods of improvement placed on a philosophical basis.

The gain to science has been correspondingly great and numerous unsolved problems in biological science find here their material for use. Economical and social science, also, here find a field for experiment and deduction. Science will therefore be the gainer in the future as truly as in the past.

NOTE ON THE BURIED DRAINAGE SYSTEM OF THE UPPER OHIO.

BY RICHARD R. HICE, BEAVER, PA.

In reading the discussion of the buried river channels in western Pennsylvania, by Professor J. C. White,* the impression is left with the reader that none of the tributaries of the Ohio and Big Beaver rivers have buried channels, but that all are flowing over undoubted rock bottoms, at, or within a short distance of, their mouths.

At the time Professor White examined this district, (1876) there was, in some cases, apparently ground for this belief, though a careful examination of other streams would have thrown much doubt on the correctness of this conclusion. Recent developments, however, have demonstrated in some cases that buried channels exist, and the nature of the surroundings in other cases, render the conclusion that the apparent rock bottom is real, a mistake.

Passing up the Ohio and Beaver from the Ohio State line, we first reach the Little Beaver. A short distance from its mouth we apparently find a rock bottom as described by Professor White,† but in building the abutments of a bridge near this same point, a depth of fifty feet was reached without finding rock. A depth that closely corresponds with that of the Ohio, which here lies on the southern side of the present valley. Near Cannelton, also, a number of miles up the valley of the Little Beaver, a well has been recently driven fifty feet through gravel without finding rock and abandoned.

Raccoon Creek, coming into the Ohio from the south, flows at its mouth through a narrow rock gorge, but below the present mouth there is a gravel terrace for about a half mile, and there is ample room for a buried channel. Passing up this stream there does not seem to be a rock bottom, except at its mouth, for several miles. The present channel makes a sharp turn up the Ohio at its mouth, while the gravel terrace, reaching on its river front at least to low water, lies in the direct course of the creek, and reaches back to the point where the course of the creek changes.

Two Mile Run, a comparatively small stream, flows through a narrow gorge in the ferriferous limestone, for about a quarter of a mile above its mouth, but passing above this gorge, it flows over a gravel bottom, parallel with the Ohio, for about a mile, at which point it leaves the valley, and enters a narrow gorge, in which no rock is found in the bed of the run for about two miles. The direct course from the narrow gorge to the Ohio, is blocked by a gravel terrace, which reaches below the present river level.

Passing up the Beaver, we first reach Brady's Run. This stream, at its mouth, also runs over a rock bottom; but, in the erection of a bridge at its mouth, it was discovered that the present channel lies immediately beside a buried one, the rock dropping off precipitously, and a well one-half mile up the stream has been driven fifty feet to rock, in a location that does not seem to be the middle of the buried channel. This well is at a point where the bounding hills rise 100 feet plus and 350 feet plus, respectively.

Connoquenessing Creek, for the four lower miles of its course, flows in a narrow rock gorge, and at one point, about one-fourth mile from its mouth, it is now flowing over a rock bottom. Above this gorge, the stream flows in a much older valley, with no indication of a rock bottom. As yet no outlet has been found for this stream into the buried channel of the Beaver, but the thick covering of morainic material makes any examination very uncertain in its negative results.

These are the principal streams, and the evidence, though not yet conclusive in all cases, clearly shows that no reliance can be placed on an apparent rock bottom at or near the mouth of the stream; indeed the Beaver itself flows over a rock bottom within two hundred yards of its mouth, as well as at three other points within less than five miles of its mouth, yet no stream has a better defined buried channel; and also shows that the time of the erosion of the buried channel was not so short as some have claimed on the supposed evidence of the absence of buried channels of the tributary streams, but was long enough to admit of the erosion not only of the main lines of drainage, but of many of the tributary channels as well.

*Second Geol. Survey Penna. Vols. 2, 22.

†2, page 16.

Messrs. P. Blakiston, Son & Co. announce that Dr. George M. Gould, already well known as the editor of two small medical dictionaries, has now about ready an unabridged, exhaustive work of the same class, upon which he and a corps of assistants have been engaged for several years.

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CORN CANE.*

BY F. L. STEWART, MURRYSVILLE, PA.

THE numerous varieties of maize now grown throughout the United States may conveniently be divided into a few general groups, easily distinguishable by the form and qualities of the grain.†

The most prominent of these are the Dents (white and yellow), Flint, Popcorn and the so-called sweet varieties. Since all sorts, however unlike otherwise, conform to the principle that the arrested development of the seed at the period above indicated, produces sugar accumulation in the cells of the stalk, and since it has been found that the sugar percentage is about the same in all at corresponding periods, it follows that the choice of the sugar planter, among the different kinds, must rest upon the most vigorous and well developed of the large-stemmed varieties that will mature their juice in any given locality. The people of our more northern States make a mistake in regarding the hard-glazed or "Flint" varieties of field corn, which are largely grown in that climate, as the best types of the species, naturally, and as bearing the best commercial type of the grain. Our western growers have already established a different standard, one which obtains now for American corn throughout the world and comes almost exclusively from the "Dent" group.

The best representatives of the species, both as regards vigorous growth and the nutritive qualities of the grain, are undoubtedly the large southern varieties, white and yellow. Maize is naturally a sub-tropical plant, but being an annual, ripening within a single season, our peculiar summer climate enables us to grow it to perfection under directly sub-tropical conditions; and in proportion as the Dent corn of the west and southwest approaches the southern type more closely in luxuriance of growth and the softer quality of the grain, does it increase in productiveness and nutritive value.

Among the different races of corn now existing the matured grain varies wonderfully, both in external qualities and composition, ranging from the "sweet" corn, with its permanently soft grain, richly charged with readily soluble food materials, on the one hand, to the "Flint" corn of New England on the other, yet the ear of the latter, in its immature stage, is but slightly different in composition and quality from that of the immature sweet corn.

It is not a little remarkable that this period of arrested development is the only period when the grain of all varieties may be said to have a common character. Experiments in stock feeding, as well as analytical results, show that it is then also in its most availably nutritious condition.

This stage now proves, also, to be a turning point in the life and economic use of the individual plant, when an alternative is significantly presented to the choice of the grower. The prompt separation of the ear at this stage conditions the full development of the sugar and the prolonged existence of the plant. But if the grain be allowed to glaze nothing can avert the almost immediate death of the plant and, excepting the seed, the destruction of the whole organized structure.

In the former case the result is equally certain and absolute. The saccharine development may be depended upon to go on until it has reached its limit, and it is as fixed and constant an attribute of the whole species as it is in the maturing joints of the sugar cane itself.

It remains for me only to indicate, in the briefest way possible, what is necessary now, practically, to make sugar manufacture a success from this new source.

First in importance is the answer to the question what varieties to plant that are best for this use. No one sort can be named which is equally well adapted for all localities, even in the main central corn belt of the United States. Everywhere in that region the period of juice-ripening is naturally brought to an end only by the frosts. Corn cane is nearly as sensitive to severe cold as the sugar cane, and throughout that region generally the aim should be to plant such varieties as will develop the milky condition of the grain by the 20th of August, so as to insure a period of two weeks for sugar accumulation by the first week in September, when the manufacturing season for the main crop would regularly begin. The following well-known sorts sufficiently matured their juice last season early in September, and most of them can be recommended for this use from Ohio westward and southward, ranking them in that region in the order named:

1. Large Southern White or Virginia fodder corn.
2. Burpee's Golden Beauty, a highly improved and well established variety of the yellow Dent.
3. Chester County Mammoth.
4. Kansas Yellow Dent.
5. Early Mastodon Dent.

The first named is the best ensilage corn grown, and wherever it will mature its ears to the roasting ear condition in August it will have the preference in sugar manufacture on account of its great productiveness and the richness of its juice. Golden Beauty has been tested from the outset of these experiments in 1884, and with the very best results. Like all the rest named, its stems are very robust, well developed stalks when trimmed weighing three pounds.

After these, but not ranking with them at all in productiveness, Stowell's Evergreen-Egyptian and Mammoth Sugar, among the sweet corn group, may be named. Their juice is not superior to that of field corn in any quality. I have no question that by selection and inter-crossing a variety of sweet corn will yet be produced which will be as productive of grain for canners' use as any that we now have and equal to the field varieties in robust stem-growth. For the sugar crop, no special preparation of the soil is needed other than is commonly required to produce a heavy crop of field corn. The seed should be sown in drills three and a half or four feet apart, and thickly enough for the plants to stand about ten inches apart in the row.

*Continued from Science, Sept. 22.

†Dr. E. L. Sturtevant, while in charge of the New York Experiment Station, corrected the nomenclature of maize and originated a system of classification, deriving the distinctive characters from peculiarities in the structure of the kernel or grain. The arrangement seems to be a natural one otherwise, and his definitions of the varieties then existing are very valuable now for purposes of identification, although some new ones have originated since then. (N. Y. State Expt. Reports for 1883 and 1884.)

Experiment has proved that a yield of fifteen tons per acre of trimmed cane from the large southern corn is, under these circumstances, an average result.†

The use of bone phosphate, and especially nitrate of potash, applied in the hill as fertilizers, is strongly to be recommended. Also, the best labor-saving implements should be employed in the cultivation of the crop. These have so far proved their value as to have reduced the cost of corn-growing within the past twenty years by about fifty per cent.

The ear should be allowed to develop until the grain has reached the "milky" stage, but never in the least beyond it, and when field corn is grown, first the ears in the husk, and subsequently when the stalk is cut, the tops, leaves and other offal should be passed through an ensilage cutter and treated precisely as ordinary ensilage. Or, when special facilities have been provided for it, the grain on the cob, with the husk removed or not, may be kept apart by itself, and after being coarsely crushed, or cut into small pieces, may be fed in that condition or dried and ground as feed for stock. In this form it is much superior for cattle food to the ordinary corn and cob meal.

To facilitate the removal of the ears the corn field, when planted, may be laid out in lands or sections of about eight rows in each, with an interval of about five feet between the outside rows of adjoining sections, so as to admit of the passage of a short-axled cart drawn by a single horse or two in tandem to carry off the grain. This will be done, and the ears in the husk properly cut and stored in the silo, or dried and ground, before the sugar season has properly begun.

At this time it is important that every vestige of an ear should be removed from the stalk; and, thenceforward until they are cut to avoid injury from frost, every day adds to the accumulation of sugar in the cells of the standing canes. But in climates where the growing season is short, or, as sometimes occurs further south, unusual cold sets in early in the fall, it is better to avoid the risk of injury to the crop by harvesting it about two weeks after the removal of the ears, when the juice will have attained a density of about 8° Beaumé, containing about thirteen per cent of cane sugar.

†Trustworthy evidence that this yield of corn cane per acre from the large-stemmed sorts is below the average is furnished in the reports from the different State Agricultural Experiment stations of the yield for ensilage when accurately weighed. Up to the period at which it is usually cut for that purpose, the conditions of growth are essentially the same as when sugar-growing is the ultimate object.

At that stage an average of about twenty-five per cent must be deducted from the gross weight of green ensilage for the weight of the immature ears, blades and tips. The remainder is to be estimated as trimmed cane.

Some examples are given below of the yield in districts well known to be less favorable for the growth of the large, late sorts than the more central parts of the corn belt.

Yield per acre:

43,700 lbs. (21.85 tons) southern "Ensilage" corn, 42,060 lbs. (21 tons) southern "Horse Tooth."—Prof. W. A. Henry, Wisconsin Ex. Sta. Report, 1891.

50-60 tons "Southern Fodder Corn," 32 tons "Mammoth," 30 tons "Southern Horse Tooth," Native Yellow Flint, only 15-20 tons.—New Jersey State Expt. Sta. Rep., 1881.

27.37 tons "Orange Flint."—N. Y. Ex. St. Rep., 1885.

40 tons "Southern" corn and "Blount's Prolific."—J. J. H. Gregory, Marblehead, Mass.

29 tons "Southern" corn.—T. S. Peer, Palmyra, N. Y.

30 " " " J. J. Chaffie, Passaic, N. Y.

27.5 tons "Blount's Prolific."—F. E. Loud, Weymouth, Mass.

46 tons or 600 tons on 13 acres.—Clark W. Mills, Pompton, N. J.

50 tons "Kentucky White."—Geo. L. Clemence, Southbridge, Mass.; quot. H. J. Stevens on ensilage.

25 tons per acre on 15 acres.—F. R. Coit, Mantua Sta., O.

20 to 25 tons "Penna. Dent."—Ralston Bros., Elderton, Pa.

If properly stored so as to be screened from the sun and rain in a cool place, the canes can be worked up within about ten days after cutting without appreciable loss. But if warm weather prevails, the interval should be as short as possible between the time of cutting and working up.

The internal structure of the corn stem is peculiar, so much so as to make the extraction of the juice from the canes by the ordinary sugar mill practically impossible. These structural peculiarities, as disclosed by the microscope and as evidenced by numerous practical tests for the extraction of the juice, make it plain that other means must be resorted to than pressure between revolving rolls to extract the cell sap.

Corn cane yields to pressure much more readily than the sugar cane or sorghum, but the elasticity of its tissues is such and the recovery so sudden after passing the line of pressure that fully one-half of the expressed juice is mopped up before it can leave the roll or the guide plate and is re-absorbed.

No other plant is capable of being exhausted of its cell contents more rapidly or thoroughly by diffusion; but the expense of that process is very considerable and its inconvenience very great. It was seen that the economy and efficiency of any system of sugar making from this plant must depend largely upon the construction of a machine which would separate the juice expeditiously and without waste. It was at last found that a sufficiently simple apparatus could be constructed by which the benefits of both milling and diffusion could be secured without any of the prominent defects of either system when separate. Special mention is made here of these facts for the reason that the only practical difficulty peculiar to this plant, in the extraction of its sugar, is thus easily overcome.

Sugar making from this or any other plant is both a science and an art, and the general principles upon which it depends are now well understood. The composition of the juice of corn cane is somewhat peculiar,‡ but not sufficiently so as to require any considerable deviation from the best systems of sugar manufacture now in vogue for the treatment of the raw juice of the tropical cane.

I conclude this sketch with a brief summary of the results reached, leaving the intelligent reader to draw his own conclusions. But it must be said, that if we would now reach any just estimate of the saccharine value of maize, in this new role, we must remember that all previous attempts to determine it were made without any knowledge of the important physiological principle upon which that value solely depends and which this investigation has now disclosed.

From a system of treatment which takes advantage of this in a practical way it follows:

1. That the highest normal of sucrose or true cane sugar in the juice, seven to eight per cent, is raised to thirteen to sixteen per cent, or almost doubled.

2. This is accomplished by a true juice-ripening process, analogous in all respects to that which marks the maturing sugar cane. It is natural to the plant under the changed conditions and is constant in all varieties of the species.

3. Its rank as a sugar-producing plant, under these circumstances, having thus been accurately determined, and a wide range of experiments undertaken to test the practicability of sugar extraction having proved that no hindrances thereto exist that are at all comparable to those met with in the case either of the sugar beet or of

‡Corn cane juice contains an organic acid previously detected only in corn silk (maizenic acid). A peculiar protein body Zein long ago found in the grain, is also found in the juice, together with several others not thoroughly investigated.

sorghum, the chemical constitution of its juice approaching more closely that of the tropical sugar cane than any other, the term *corn cane* here used to distinguish the plant when in this condition of development will, I trust, not seem to be misapplied.

4. The utilization of the plant in this way is the most thorough and perfect possible, because it takes advantage of the fact that the development may be so controlled as to secure from the same individual plant at two different periods of its existence: first, the grain product, when in its most nutritive and assimilative condition to serve as feed for animals, or as bread food, and second, and conditioned upon the first, a matured condition of the highly organized substances in the cells of the living stalk, and their safe storage there for an indefinite time, a full crop of sugar being thus easily attainable as the result.

5. No risk is run by the grower in producing corn cane, because it is at his option, up to an advanced stage of its growth, to choose whether he shall harvest it as a grain and sugar crop combined, or as ensilage simply, or as the ordinary product, the hard ripe grain.

6. To secure a healthy and luxuriant growth and a full crop of any of these products the requirements as to climate, soil, tillage, the use of fertilizers, etc., during the true growing period, are almost precisely the same in all cases. No new system of agriculture is necessary to be inaugurated to make sugar-growing at a profit a success, no new plant is to be acclimatized before its merits can be tested, but following a system of culture with which we are familiar, making one simple but radical change only in the routine, we have practically a new plant in the new uses that it serves.

7. It follows from this that the cost of sugar-growing from this new source, ought to fall much below the average cost of producing it from any other plant. This is still more evident if we consider that the sugar crop from corn is capable of being brought to full maturity in a relatively short period, as compared with either that from the sugar cane or the beet; that a ton of trimmed corn-cane, bearing at least as high a sugar percentage as the sugar beet, can be grown here at about one-half the cost of a ton of beets, not counting the immature grain and fodder ensilage produced along with it. The latter represents an added value almost equal to that of the sugar for which the sugar cane furnishes no equivalent whatever, and neither the beet nor sorghum any that will bear favorable comparison with it.

8. The enrichment of the juice of the corn plant grown for ensilage alone, or for use as dried fodder, secured by the timely removal of the ears and the curing of that part of the crop separately, is of scarcely less general importance than when sugar-growing is the main object.

9. It is evident, also, that the full limit of this enrichment has not yet been reached. The capacity of Indian corn, for rapid improvement through judicious selection and hybridization, gives promise of securing new races possessing still more valuable qualities for sugar production than are found in any now existing.

10. Among the benefits which the establishment of the sugar industry from maize will confer upon American agriculture, a prominent one will be to check over production of the hard-ripened grain. When it is known that from the same plant equally valuable products in other forms are regularly attainable, which, being substituted for the ordinary staple, will secure the benefits of a wholesome limitation to the production of the latter, the area devoted to the growing of the plant will profitably be enlarged to any extent to meet the enormous capacity of our western soils to produce it.

In giving to the public these conclusions it is, perhaps, scarcely necessary to add that the motive of this investigation was simply to fix the value of maize, under the new conditions, as a sugar-producing plant.

Table:—Relative composition of the juice of "corn cane" and sugar cane.

	Indian Corn.								East India Sugar Cane.* Carefully sampled good average cane. Aska Dist., Madras. (Gill.)			Louisiana Sugar Cane.† Magnolia Plantation. (Wiley.)			
	Period of Early Growth.				Period of Saccharine Development.										
					"Southern Fodder."		Penna Yellow Dent.	Golden Beauty.				Mean of 4 years.			
	In Tassel.	In Silk.	In early roasting ear.	Ear removed.	One month after removal of ear.			54 days after ear removed.	2 feet of top.	2 feet middle.	2 feet next root.	1884.	1885.	1886.	1887.
Specific gravity	1012.6	1034	1048	1036	10674	1071	10692	10694							
Cane sugar	0.	2.90	6.70	10.32	13.90	14.94	14.68	14.63	21.31	14.55	14.58	13.05	12.11	13.50	13.69
Glucose	1.87	3.00	2.50	1.90	1.61	1.16	1.08	1.04	2.86	1.65	1.68	0.67	1.02	0.61	0.77
Organic matter not sugar, and ash.	1.13	2.80	1.80	1.18	0.91	1.20	1.14	1.25	0.83	1.20	0.74	2.82	2.67	2.09	1.81
Total solids	3.00	8.70	11.00	13.40	16.42	17.30	16.90	16.92	15.20	17.40	17.00	16.54	15.80	16.20	16.27
Water	97.00	91.30	89.00	86.60	83.58	82.70	83.10	83.08	84.80	82.60	83.00	83.46	84.20	83.80	83.73

*Gill's analysis, quoted from Allen's Organic Analysis, Vol. 1, p. 261. (1885.)
†U. S. Department of Agriculture, Bulletin 18.—Wiley. (1888.)

Disparagement of the earnest efforts that have for many years been made, and are still being made, to make beet sugar growing in this country successful, has not been thought of. But it must be remembered that every industry dependent upon plant growth and development for its existence must have due respect to the peculiar conditions of climate and soil prevailing in the country where it is proposed to establish it. It is now well known that the climatic limits of successful maize-growing on this continent are very wide, and those restricting the beet for employment in sugar manufacture are quite narrow. Here, as elsewhere, the foundations of success are laid in natural laws. And one thing seems clear: the typical sugar plant for America must be one possessing the robust health and all the qualities which are supposed to spring from being "native and to the manor born," and which, while meriting and needing, perhaps, the fostering care of the home government as the basis of a new industry, at the start, yet must prove its ability to stand alone, unsupported by a bounty or any other merely adventitious aid.

THE METEOROLOGICAL CONGRESS.*

MONDAY, August 21st, at ten A. M. the congresses of the Department of Science and Philosophy of the Congress Auxiliary of the Columbian Exposition were formally opened at the Memorial Art Institute of Chicago with an address of welcome by the President, Mr. C. C. Bonney, followed by responses from representatives of the various special congresses. At the close of this general session the different divisions met in rooms assigned to them, the Division of Meteorology, Climatology and Terrestrial Magnetism meeting in room XXXI, in which the regular sessions were held daily from 10 A. M. to 2 P. M. from August 21st to August 24th.

The chairman of the Congress not being able to be present in person the first day, Prof. F. H. Bigelow, representing Prof. Mark W. Harrington, opened the session at eleven A. M. of the 21st with a few words of welcome and a statement of the objects of the Congress.

The Congress had no legislative authority. The main purpose, as previously announced, was to collect together a series of memoirs "outlining the progress and summarizing the present state of our knowledge of the subjects treated," and to print them in full in the English language.

The meetings, while thus making the reading and discussion of papers a matter of secondary importance, were by no means lacking in interest or profit to those who were present. But few of the papers could be read in full, owing to their great number and the absence of many of the authors. In all about 130 papers were read by title, in abstract or in full, forming a most valuable collection of memoirs prepared by writers of authority in their respective lines of research.

Among so many papers of merit, a simple list of which would occupy several pages, individual mention cannot be fairly attempted.

While the papers were read in general session, they were assigned, in the program, to various sections, according to the subject, each section being placed in charge of a responsible chairman.

Section A. Prof. C. A. Schott, U. S. Coast Survey, and Mr. H. H. Clayton, U. S. Weather Bureau, Chairmen. The papers of this section are devoted to instruments, their history and relative merits, and to methods of observation, especially to methods of observing in the upper air.

Section B. Prof. Cleveland Abbe, U. S. Weather Bureau, Chairman. This section is the most extensive in its scope, dealing mostly with questions in dynamic meteorology; much attention is given to the study of thunderstorm phenomena in various countries.

Section C. Prof. F. E. Nipher, Washington University, Chairman, comprises a series of sketches of the climate of different portions of the globe.

Section D. Major H. H. C. Dunwoody, U. S. Army, Chairman, is devoted to the discussion of the relation of the various climatic elements to plant and animal life.

Section E. Lieut. W. H. Beehler, U. S. Hydrographic Office, Chairman, deals with questions relating to marine meteorology, particularly to ocean storms and their prediction, methods of observation at sea, and international co-operation. During the reading of a paper on the work of the Hydrographic Office of the Navy, Lieut. Beehler had on exhibition a fine bust of Lieut. Maury by the sculptor Valentine, of Richmond, Va.

Section F. Prof. Charles Carpmael, Director of the Canadian Meteorological Service, and Mr. A. Lawrence Rotch, Director of the Blue Hill Observatory, Chairmen, comprises papers relating to the improvement of weather services and especially to the progress of weather forecasting.

Section G. Prof. F. H. Bigelow, U. S. Weather Bureau, Chairman, deals with problems of atmospheric electricity and terrestrial magnetism and their cosmical relations.

Section H. Prof. Thomas Russell, of the U. S. Lake Survey, Chairman, has to do with rivers and the prediction of floods.

Section I. Oliver L. Fassig, Librarian U. S. Weather Bureau, Chairman, is devoted to historical papers and to bibliography, with special reference to the history of meteorology in the United States.

Prof. Mark W. Harrington, Prof. F. H. Bigelow, Capt. P. Pinheiro, of Rio Janeiro, and Lieut. W. H. Beehler successively presided over the meetings. The printed program distributed at sessions of the Congress contains a list of all papers presented; copies of this may be obtained from the Secretary upon application.

At the close of the last session a resolution was offered calling for recommendations by the Congress relating to (a) international co-operation in observations of auroras, (b) simultaneous Greenwich noon observations daily at all stations on land and sea, in addition to observations at other times, (c) investigation of the earth's magnetic polar current and the exact determination of the solar rotation. As the Congress had no legislative authority, it was agreed to hold a special session for the consideration of these questions after adjournment, on the following day.

Preparations have been begun for the printing of the papers and an effort will be made to complete the work at an early date. Oliver L. Fassig, U. S. Weather Bureau, Washington, D. C., is the Secretary.

*Held at Chicago, August 21st to August 24th, 1893.

SALT TIDE MARSHES OF SOUTH JERSEY.

BY JOHN GIFFORD, SWARTHMORE COLLEGE, PA.

THE mainland of the peninsula of South Jersey is fringed by many miles of marsh meadow. At times this level plain is completely covered by water. It consists of a mass of soft blue-black, bad-smelling mud, covered with a thick sod of grasses, rushes and sedges, and intersected by many winding, reed-fringed creeks, shallow bays, salt ponds and thoroughfares.

These marshes are separated from the ocean by a long line of low, sandy sea-islands, between which there are inlets through which the tides flow swiftly.

This stretch of marshland is of very recent origin. During Indian times it was probably a shallow sea. This accounts, perhaps, for the enormous quantities of clams and oysters which then existed. The majority of the bays in the marshes are very shallow and may, also, in the course of time, become unfit for oysters.

The rivers of South Jersey holding fine sand in suspension flowed into an ocean where there was practically no current. This material was then, in consequence, deposited, and there was thus formed a long sub-marine bank. This tripped the waves into breakers, which lifted the sand into a long line of low sea-islands.

The combined estuaries of these rivers formed a long, shallow inland sea, in which, owing to the slackening and meeting of currents, enormous quantities of silt were deposited. Wild water-fowl and winds disseminated the seeds of grasses and sedges on the mud bars, which were soon formed. The decay of each year's vegetation and the scum of mud left by every tide caused a gradual thickening of the sod. Three hundred thousand acres of marsh region have thus been recently formed.

Being an estuary, the scouring force of the tides prevents the formation of extensive beaches on the bay-side of Jersey. The sand is held in suspension until the cur-

rent is slackened by striking the ocean where a shoal is forming.

Since the formation of these marshes the beaches, by the action of wind and wave, have been moving inland. Inlets are becoming shallower, and the beaches, in places, have been completely blown from their original bed over on to the marshes, so that the marsh mud is often exposed on the ocean side.

This accounts for the size which the trees attain in these places. Many beaches support only a shrubby vegetation, others are covered with beautiful forests of trees of surprising size. Red cedar, holly, sassafras, oak, liquid amber, sour gum, magnolia, sweetgale and grape vines grow to be unusually large. Some of the finest specimens of holly in existence may be found on several of these beaches, and the red cedar which grows there is more durable than that of the mainland. The size of these trees is due to the fact that their roots have penetrated through the sand of the beach into the rich, black mud of the marsh beneath.

These forests are doomed. The wind picks up the fine white sand of the beach and piles it in dunes. These are often as high as the tree tops and are moving gradually inland, leaving only a mass of dark gray trunks behind. Unfortunately the trees themselves prevent the west and and north winds from blowing back the sand.

The fact that Jersey is slowly sinking complicates these changes. The marshes, in consequence, are intruding upon the mainland. Even white cedars, which only grow in pure fresh water, have been found buried in the marsh. Little islands and Indian shell heaps are slowly disappearing.

In the formation of these marshes organic agencies play an important part. An examination of the mud in shallow bays and salt ponds shows enormous quantities of beautiful diatoms. There, too, are many kinds of shells. Other animals, especially those of the crab tribe, completely honeycomb the marsh in places.

These meadows are very rich and valuable for farming. When banked and sluiced, although they shrink, they freshen and, after being worked for a time, yield enormous crops. In several places in South Jersey they have been converted into flourishing farms. In other places up the rivers they have been abandoned because of the muskrats which undermine the banks.

These vast stretches of marsh are richly colored, and at times, in places, are covered with white, pink and yellow flowers. They are alive, in season, with wild migratory water-fowl, infested with flies and mosquitoes and flecked with the sails of boats moving in the creeks and bays. In winter they are deserted and dreary, the monotony of which is only broken by a hay or fish house here and there or the remnants of a stranded schooner.

The collecting of the hay which grows on the marshes is one of the leading industries of that part of the state. It is still, in many places, cut with the scythe and carried on hand poles to large clumsy scows, which are rowed with two long oars to the landings.

There are 300,000 acres of marsh region in South Jersey. At least one-twentieth of this is cut for hay. An acre yields, without sowing or care, other than a little ditching, at times, and burning once a year, at least one and a half tons. The many creeks which bend in every direction render it easy of access. It is worth at least six dollars a ton. The annual crop is worth then not a cent less than $135,000.

The marshes are often too soft for horses; in places they are provided with wooden shoes, and many meadows are hard enough for the use of machines.

This hay is often baled and shipped away. The greater part is consumed at home. Poor qualities are used by glass factories for packing purposes.

The two plants of greatest value yielding hay on these marshes are *Spartina juncea* or "salt-hay" and *Juncus gerardi* or "black-grass." The one is a true grass, the other a rush. The salt hay is light in color, contains few seeds, is cut late in summer and is fed to horses. The black grass grows in brackish regions, is full of seeds, is dark in color, is cut in mid-summer and is fed to cattle.

If reclaimed on a very large scale, as in Louisiana, the writer believes that these marshes may and will soon be converted into flourishing farms.

METHODS OF PRESENTING GEOLOGY IN OUR SCHOOLS AND COLLEGES.*

BY MISS MARY E. HOLMES, PH.D., ROCKFORD, ILL.

Before offering any suggestions as to "methods" of presenting this study, let us state a few axioms:

First. For the successful study of any subject there must be some foundation.

Second. Comparatively few of our high school pupils enter college.

Third. The large majority of school age will not advance beyond the grammar grade.

Fourth. The impressions earliest made are most enduring.

Fifth. If we would make geology a life force, a life inspiration to the masses generally and to those in our high schools and colleges, we must begin with the little children.

How early a child's attention may be profitably called to the elements of geology may be questioned, but I think as soon as he can talk, and understand what is said to him. Of course the first lessons will be very, very simple—mostly in *form* and *color*. He will gladly gather for you the "pitty stones," and you will notice that these, gathered *by himself*, and when *alone*, are generally either definitely colored, or smooth rounded ones, or smooth flattened ones, few being angular. With your aid let him separate the rounded from flattened, calling his attention to the difference in *shape*. Mix them and separate again. Repeat the process many times, at first always letting the child *hand you* the stones, you frequently asking: "Where shall we place this one?" Later, let him place them himself. In a few days he will have so mastered the distinction between *flat* and *round*, that he can separate quite correctly a large pile. Never continue the lessons till he is weary. When such signs appear suggest that he run out doors and play. In all probability he will return with another pocketful of stones. Appear pleased with his acquisitions and *be* pleased. He will detect any insincerity. Give him a box, or a low shelf of his *very own* for his treasures. With encouraging words, the child will thus spend many hours; they are not play, nor work, but happy, instructive seasons.

Having learned to separate round from flattened stones, call his attention to rough, *angular* forms. He will quickly note the difference. Show him that these are *angular* because *broken* from a larger stone. Illustrate by some broken toy of his own. Also show him how to make more angular ones by cracking these with a hammer. If he pounds his fingers, a little experience will remedy that as a frequent future result. He cannot appreciate the smoothing effect of water, so pass it by. Many lessons upon surfaces may be received unconsciously in this way, the child learning how to use his eyes, and to compare one object with another.

Next, take the *colors* of the stones. Separate them into piles, *dark* and *light*. Separate again the blackish, the red-

* A paper read before the Woman's Department in Geology in the World's Congress Auxiliary of the World's Columbian Exposition at Chicago, August 21, 1892.

dish, the gray and the white. Do it with him many times, but each time he will do it more and more himself, till he accomplishes it alone. Should any pebble have a *hole* in it, or any special feature, his eye and finger will be sure to find it, and an exclamation will burst forth: "See!" He has *discovered* something. He now looks for more, like, or similar to it.

Next, teach him to select them according to *lustre*, if in a vicinity where micaceous or other specially lustrous rocks are frequent. If not, as a special privilege, let him *wet* some in a *bowl of water* while the others are dry. The difference he quickly sees, and next time, if no water is at hand, he will be more than apt to wet them with his tongue, and exclaim again "See!" his tone and look indicating that he *recognizes* an effect upon the stone like that produced before by the water. Here he has really learned that one general agent, under two forms, from two different sources may produce a similar effect. As to kinds of lustre, he may be readily trained to recognize *pearly*, like the inside of the shell on the mantel, and *glassy;* also that the *absence* of lustre is *dull*. Of *degrees*, he can comprehend *shining* and *glistening*, and learn the words as well. A child does not need such short words as we often think. He delights in mastering a "big word," if only for the protracted sound, but if it conveys a pleasant thought, his interest is greatly intensified.

Next, teach *hardness* by rubbing two stones together, and by letting him try to scratch them; first with a *nail*, and second with a sharp-edged piece of *quartz* or *flint*. He can make perhaps three piles—those *soft*, easily scratched with anything; those *harder*, only scratched with the nail and quartz, and those *hardest*, not scratched by the nail, but by the quartz. These distinctions are crude, but real, to the child that recognizes them.

What has been thus pursued from day to day in the realm of stones, if the mother or kindergartner is wise, should have been carried on also with plants, insects, and birds, even some lessons on the "twinkling stars." Of these, botany, zoölogy, and astronomy, we do not now speak, but, be it remembered, that no single science at once bears as strong a relation to, and is so dependent upon, a knowledge of botany, biology, chemistry, mineralogy, physics and astronomy, as is geology. It emphatically furnishes a foundation for them, and in turn must look to them for the interpretation of its data.

By the time a child is of ordinary school age, under such a course of observation, comparison and generalization as the foregoing would suggest, he has formed a *habit* of being *interested* in *everything about him*. If he is a city child, he can have learned all here outlined, or its equivalent; and if a country child, even more, for *he* is constantly in direct communication with Nature's open album of new and beautiful objects for observation and subjects for reflection.

Continuing our study of stones, we will try the action of *water* as a *solvent*. The teacher should place in the pupil's way some varieties, as rock salt, or a hard lump of common salt, which are *quickly soluble*, alum, *not* as *quickly;* a rusty nail that will color the water in a few hours, and the child's own quartz pebbles, *insoluble*. Call attention to the different actions. With the salt a lesson on *saturated solutions* may be given. Having shown the effect of water, try *acids*—strong vinegar or hydrochloric acid—upon various stones. Some are unaffected, some hiss a little, some boil violently. Can you *see* anything passing off? No. Can you *hear* anything? Yes; there is a bubbling. What *do* you *see?* The bursting of the bubbles. Why do they burst? An *invisible gas* is passing off. Have you ever seen anything else boil *like that* in a *bottle* or a *glass?* Some pupil will suggest "*beer*" or "*soda-water*." Yes, and the same cause produces both; this unseen gas we call *carbonic acid gas*. Let the pupils taste a little cooled, boiled water, and some fresh, hard, well water. One tastes *flat*, the other *good*. The same thing that escaped from the stone, beer and soda water, gives, in the main, the difference of taste between these two waters, viz.: *carbonic acid gas*. Try more stones with the acid. Some hiss, some do not. All that *do*, have *this gas* in them, and are called *carbonates*. Try the acid again on a *carbonate*. It boils; continue pouring it slowly till boiling ceases. Note the effect; the stone has turned to *sand-like particles*. Take another carbonate, pour on acid; it boils. After a moment pour on some *aqua ammonia*, the boiling ceases; pour on more, the stone does *not* crumble. Take a third carbonate; pour on ammonia only. There is *no* apparent effect. In the first case the stone crumbled; in the second, the crumbling was checked, and in the third, there was no change. Evidently something *holds* the *grains together*. What? Some child will say "that gas that blew away." What is it called? What are all such stones called? Drill on this thoroughly. Illustrate solubility and carbonates also by baking soda and cream of tartar. Dissolve a little of each in tumblers of water. Let the pupils taste both in the dry powder. One, soda, is a *brackish sweet;* the other, tartar, is a definite *sour*. Pour part of the soda solution into the tartar tumbler; boiling or *effervescence* is instantaneous. Taste the tartar water now. *Almost sweet?* What has been given off to produce this change? Pour the rest of the soda into some *sour milk*. It, too, effervesces. Taste it. It is *sweetened*. The sour substances are *acids*. This element that sweetens them is an *alkali*. Ammonia is another alkali. Most alkalies are *odorless*, and all, if strong, will burn the skin severely. So children should never taste nor play with things in bottles without permission. Give some tiny experiments with *heat*. Throw several stones into a hot fire. Perhaps some *swell up*, some grow *porous quite rapidly*, others *more slowly*, and some are *unchanged*. Some change color, and some discolor the flame nearest them—making it *yellower*. Tell the pupils the explanation of this will come later, but because heat *does* this sometimes, it is used as a *test*. As far as possible, always use the children's own stones, and let them, in sections, do the work *after you*. There will be a little rivalry as to which can do it best and quickest. They will not weary though they see the same thing performed many times. If certain ones are peculiarly apt, let them, *at your order*, perform the experiment for the first time. Among the children's fragments there will be a large amount of rubbish. From time to time the teacher can propose "to assort the collections," and casually remark: "So many of these are so nearly alike, which are the *most perfect* of their kind? Let us lay such aside, and put the rest in a reference pile for a time of need." The plan is readily accepted, the "collections" greatly reduced, and the refuse piled in a corner out of doors, to gradually scatter.

No lessons will be more acceptable to the pupils than those of *erosion* and *sedimentation*, taught by calling attention to the water in the streets and gutters after a *gentle* rain, and after a *heavy* one, a *short* one and a *protracted* one. They will readily see its *assorting* effect. They will notice the little *terraces* made, and that the form of these—their comparative width and height—depends upon the *velocity* as well as *amount* of water flowing along. Note how they narrow and deepen when passing under crosswalks, and that the current is swifter. Having noted these things, call attention to any ravines, or creeks, or the river and its bank. Show that when a creek widens, the edges, on either side, are apt to be *marshy*. Why? Notice the different appearances of the bottom. If gravelly, is it clean or dirty? Why? Some pupil goes too near the edge, and the bank caves off. Why? A shrub

is nearly undermined. Why? Explain how the earth, carried from these parts, is dropped, gradually, farther on.

Thus far our work has been adapted, in the main, to the city pupil with only a limited field for his sand and gravel explorations, the street gutter and an occasional excursion to some picnic ground, a grove and a creek. If a bank of *Drift* should be at hand, he will have a bonanza for these happy lessons. Pupils will then find some stones with strange markings, suggesting a *shell*, or one of the *corals* on the mantel. They have learned to observe and compare, and now draw their own inferences with a *certainty* that these *are* shells and corals, *in the stones*. Is the marking the inside, or outside, of the shell? Is it a complete shell, or only one valve? Did it probably *have* two valves, like a clam, or was it like a snail, coiled or straight? Teach them to note not only degrees, but kinds of resemblance and difference; really to distinguish between analogies and homologies. A child often really *knows* more of a thing than he has the power to *tell*, unless drawn out by questions. How did these shells and corals come *here* so high above the water? Mother's shells came from the distant ocean. Once, long, long ago, did the ocean ever come *here?* and were these *alive* then? Yes, but they are "fossils," now, petrified thoughts of God, kept all this time for us to study. They are masks without the actors, poems of life written unconsciously. Tell the class something of the habits of similar animals now, enough to stimulate them to further research. *Never*, by chart, picture or word, *tell* them *directly* what they can find out themselves from their own specimens, or walks, or speculations. *Always manifest an interest* in every new thing they discover and bring you, however trivial it seems to you. To lead them on, if possible, ask some question the answer to which is not obtained from a casual examination.

With a little plan on the part of the teacher, a very fair *working cabinet* of the locality may be built up *for the school-room*. Most children will gladly give their best specimens "for the school," especially if their names may appear as the donors upon the labels. Here they get an idea of *permanent labels* and *how to prepare them*.

Before advancing farther, we may note some of the incidental, but not less valuable, benefits to accrue from these studies—not only *the habit* of *interest* in *common things* —habits of observation, investigation, comparison, and classification, but those of industry, honesty, a supreme love for truth, a seeking for it earnestly, and a careful examination as to evidence, also to recognize the fact that one may often, by a *single* omission, reach a *wrong conclusion* and have to *acknowledge* and *correct* his error. These effects are not immediate, not strikingly apparent, but sure and enduring. I venture to assert that no single study in the usual curriculum of high school and college, aside from *the Bible*, will more fully fortify against evil influences in youth, adolescence and middle life, and cheer in declining years, than an early, continued and devoutly reverent scientific study, pre-eminently of geology, for it gives constant occupation to the senses and tends inevitably toward the highest and grandest inductions and deductions. The pleasures of observation any and everywhere, of the imagination and of reflection, connected with this science, involving as it does, and must, more or less, all the others, are themselves almost a guarantee against vice. If "the undevout astronomer is mad," much more the undevout geologist, who *touches* the very handiwork of the great Creator of this and all worlds.

Thus far we have considered *Primary* and *Grammar* grade work. In any grade, teacher and student should work *together*, and with the same great end in view. A stream rises no higher than its source. No extended laboratory is essential and but few instruments, though the more complete the *reference library* the better. President Garfield said casually that "a saw-log and the society of Dr. Mark Hopkins was a university of itself," so largely is the student the result of his *environment*. If he feels in every breath, sees in every act of his professor or teacher, a consecration of energy, a spirit of investigation, a love and zeal for the work, born of intelligent enthusiasm, every latent power in that student's being is, perforce, awakened, and his whole life is aglow with scientific research. Books have their place, and a very large one, yet any geological study founded on book knowledge *alone* is of little worth. The student *must* verify for himself, and learn by many mistakes to recognize and interpret the ordinary geologic phenomena of the field and laboratory. The teacher and pupils, with hammer, cold chisel, compass, basket and note-book, and pencil, should go together to the field, the quarry, the ravine, the gravel bank, all these being lacking, to the gutter of the street after a heavy rain, or even to the open prairie. Just the direction of the geologic study, whether structural and physical, or palæontological, must necessarily depend upon the locality of the school. The prime object to be secured is to train pupils to see for themselves, to collect their own data, then study and arrange them, drawing their own deductions. Every teacher should require of the pupils carefully drawn sections or diagrams of this or that special locality, the course of a creek for half a mile, a ravine, a sandpit or a particular quarry. So far as may be, let them be on an *approximate* scale, giving altitude, thickness, dip and strike of strata, etc. They should also collect any fossils characteristic of the layers, labelling each as from its layer, to avoid confusion in farther study. Having made a number of these investigations, each pupil should compare his or her own papers and specimens one with another, noting down their resemblances and differences, how the strata alter from one layer to another; what fossils are common to all, which abundant, which frequent, which rare; which, whether abundant or rare, are confined to a limited district, etc.

In all science study and teaching our first object should be to be *natural*. In geology this requires a familiarity with *rocks*, their form, structure, position and chemical composition. If the course, as previously indicated for primary and grammar grades, has been followed, the student is now ready, with great zeal and profit, to take up more extended field observations, and the regular lecture with a text book. All field study should be followed by a lecture or quizz by the teacher, developing the knowledge of the pupil, and adding to it materially by references, with page and paragraph, to the best authorities, the presentation of charts, pictures, photos, specially illustrative specimens, chemical experiments, etc. Far better results are obtained if, under each head, some single illustration is taken and traced as far as possible. For instance, under igneous agencies take *Vesuvius*, giving *every* thing that can be gathered, its cone, materials erupted, and their amount, the buried cities,—include, it may be, even some poetic references. Then will naturally follow the *kinds* of volcanoes, their *location*, *age*, the *theories* of their origin, and *earthquakes* and their phenomena. Under aqueous agencies nothing can be more stimulating and convincing than a study of our own Mississippi River, as fully described by Abbott and Humphrey. Let the pupil identify all he can. For erosive action of water on a large scale take Niagara. For both erosion and sedimentation, on a *very* small but quite *as true* a scale, take a city gutter, near its source and at its outlet. Present one typical illustration under each head so fully that it will be a *standard* for the pupil in all similar processes, whether in field, laboratory or class room.

In our own section, about Rockford, Ill., we have the Galena Division of the Trenton, outcropping in various

places along Rock River, and exposed in many railroad cuts. While the general exposure is only of the yellow or buff stone, in several localities it has been quarried down to the blue. With a piece of each color in hand, and the quarry itself under close inspection, a valuable series of facts may be discovered by the pupils—the strata joints, seams, etc., whether they are equally distinct in all parts of the exposure, whether adjoining strata are decided contrasts; if so, in what respects, color, texture, homogeneity, hardness, etc. Enquire which strata are the oldest, and why so decided? Which strata are best adapted to the purpose of quarrying? As a building stone, will it be greatly affected by water? Weigh a fragment in its natural condition; dry it as fully as possible and weigh again,—a druggist's scales will give the change. Judging from various exposures, does the stone "weather" smooth or in depressions? Can you tell the original upper surface of a flagging stone from the lower? How? In building, is it better to "lay" the stone with any reference to this *original* surface? Why? With a hand magnifier of ordinary power, examine the texture of the rock, coarse or fine? Are there occasional little "pockets" in it? Is the sand in these the same as in the rock itself? Those white, irregular stones, imbedded here and there, what are they, and how do they differ from the others? They are flint or quartz,—strike them sharply with a piece of steel,—fire flies. What are those little brick-red masses here and there? How do they differ in texture and shape of grains? Is the rock firmer or less firm in their vicinity? They are iron nodules. Are they beneficial? Why? Note the reddish powder around any nodule, if kept damp, and how the stone streaks. What other forms have you found? An incrustation? *Yes. Touvertine*, a deposit of carbonate of lime from the water trickling among the strata. How do you know it is a *carbonate?* This time try nitric acid instead of hydrochloric on these peculiar forms, carbonate, quartz and iron,—note the difference of action. In this way a thousand things familiar to every geologist will be learned by the student, and bring to *him* the inspiration of a *discovery*.

The pupils have gathered all the fossils they could, whether many or few. Some are manifestly *corals* and a form allied, fossil *sponges*; others are shells. Separate them. What do they suggest as to the *origin* of the rocks? *Where* were they formed? Are they more closely allied to salt or fresh water species? Examine carefully the valves, hinge line, ribs or striæ, beak and umbo, sinus and folds. Find specimens giving both internal and external structures or characteristics, if you can. Distinguish between a *cast* and the *fossil* itself. Are the casts of any value? What? Classify, as well as may be, all the fossils collected, according to *form* and according to *internal structure*, so far as it can be traced. Not all shells that look similar on the outside belong to the same genus, nor do all belonging to the same genus look alike, necessarily. After the student has made a goodly collection of fossils and facts about them, the teacher may lead him on, with State Reports and other authorities, till the final identification is reached, but the pupil should take every step himself for himself, when able. In all these lectures and quizzes, the blackboard is an invaluable help, making diagrams as you progress, rather than present a more perfect one, completed before the class enters.

At Rockford, also, we have a fair exposure of the *Drift*. After studying the stratified rocks as such, the class is ready to study stratification as presented here, and to make further maps or diagrams. Note the sizes of the gravel stones and their arrangement. Is there a regularity in distribution as to *size* of pebbles? Few better fields in a prairie section can be found for the varied forms of quartz. Occasionally bits of mineral are found, —*galena and copper*,—the former suggesting the mining districts of Northern Illinois and Southern Wisconsin; the latter, from its form, the Lake Superior region. Fossils of various kinds are not infrequent, but of genera and species quite different, usually, from those found in the quarries and railroad cuts. The drift has brought them from several formations and from long distances. Often the internal and external structures of these specimens are better preserved than in those imbedded in the rock. Indeed, most of the best and most exact descriptions of palæozoic corals have been based upon drift specimens. The pupils having made collections of the different varieties of *rock* from the drift, the teacher may here give some ready tests of identification for common forms, or some simple mineralogical table. We have few bowlders, but those few, with the drift rocks, submit themselves to the same kind of study as rocks *in situ*, whether macroscopic, microscopic, or chemical, so are well adapted to all petrographic study, save geographical limits.

At Rockford we have the deep, heavy prairie deposit, black as are all rich soils due to the decay of vegetable substances. If this soil is *burned*, there is little change, save in color,—the mass is argillaceous matter, with a little fine sand. The stratification noticed in the walls of wells, and in artesian well borings suggests the same agency as the quarry and the drift, viz.: *water;* but the occasional shell fragments found bear little resemblance to those in the quarry, rather to our fresh-water Unio, Anadonta and Paludina, genera still living in the rivers and marshes. The inference, then, is that at some remote time, but later than the quarry and the drift with their salt-water fauna, there was a fresh-water lake, perhaps an arm of Lake Michigan, reaching out toward the Mississippi River, or the Mississippi extended this way.

As the conservation of energy has given us a new physics, so the microscopic study of rocks and fossils has given us a new geology. Though microscopic rock-sections were first made in 1854, it was not until they were introduced into Germany a few years ago, that they became an active agent in geologic research. Only by this careful method can these petrified thoughts of the Creator be fully understood. Palæontology is essentiallybiological, dealing with the plants and animals *on* the globe rather than with the life of the globe, but it has rendered an inestimable service in determining the question of *evolution*, so the microscopic section will be of inestimable service to the petrographer with his crystalline rocks, whether volcanic, plutonic or metamorphic. For making these sections let the pupils use their own ingenuity in preparing the simple apparatus really essential. If a section cutter is at hand of approved pattern, or an electric or foot-power lathe, very well; but if not, it is *just as well*, for with cold chisel, hammer and file, the student can easily reduce his specimen to a proper size for grinding. The superficial surface may be as large as preferred, but the thickness not more than one-fourth inch, if the intention is to make a *translucent* slide. If only one surface is to be ground, the only care will be to get the *angle desired* for the examination. For early work only *calcareous* specimens should be used. Let the student furnish himself with a plate 12x16 inches of floor glass, smooth on one or both sides; a half-dozen pieces of double or treble thick glass 2x2 inches, a half-dozen spring clothes pins, emery of 4-7 grades, the finest being emery "slime;" a piece of chamois skin, stretched tightly over a smooth board to polish upon; some Canada balsam, hard and soft; some alcohol, a lamp and some matches, and a little water. With a few needles in wooden handles, and a firm table to work upon, he is independent of surroundings. His patience, time and skill will be taxed, but these are the

wrapping paper and cord to secure this trophy of the past, and draw from it its inmost secrets. The grinding is simply friction with emery and water till the first face is prepared, and polished on the chamois skin with *dry* emery *slime*. This should be as perfectly done as possible. The specimen may be considered as finished at this stage, if no *complete* examination of *structures* is intended, no tracing of homologies in various genera and species. If this exact study *is* to be prosecuted, on one of the small glass pieces, polished surface down, imbed the specimen in balsam, just hard enough and deep enough to securely hold it, but not so hard as to crack off, as the grinding of the second surface advances. Care must be taken to hold the glass *horizontally*, lest the specimen be of unequal thickness at the close. When *nearly translucent*, great care must be taken by grinding *lightly* and more and more lightly, till the work is complete and the polishing done. Warm the balsam which still holds it to the glass, and delicately slide the well-earned treasure to a new microscopic slide, 1x3 inches, on which is a drop of hot balsam. This successfully done, remove any air bubbles and lay on the cover glass, removing bubbles again. Clamp it with a clothes pin till dry and cold, then remove all surplus balsam with turpentine, taking care that it does not also run under the cover glass. It is now ready for study. When several specimens of different species or genera of *Rugosa*, for instance, have been made, fine lessons may be drawn in homologies, especially of mural, septal and tabular systems.

As the large majority of students will not carry their scientific studies, as such, farther than the requirements of the college curriculum, it is eminently important that their attention be called all along to certain prominent things *as* prominent, as the great questions to be sought out. In giving these special points of the field in general, the teacher or professor will naturally present in a more extended way that special field which has most attracted his or her own attention or investigation. For reference and for present benefit the pupils should each, under the eye of the teacher, make a geological map of the United States; one of his own state on a larger scale, and of his own section on a still larger one. He should also number carefully and permanently his specimens, using a tiny circle of paper and glue unaffected by ordinary moisture, these numbers corresponding to those on labels bearing name of formation, group, genera and species, with the date and locality.

In preparing this paper I have been painfully conscious of its inadequacy and its great imperfections, yet from experience and observation I hope to have measured an arc in the circle of scientific and geologic education in our schools whose circumference may be eventually completed.

LETTERS TO THE EDITOR.

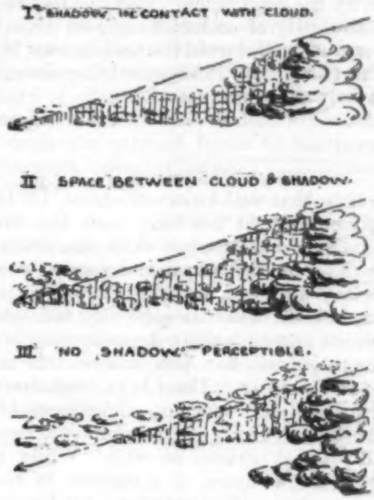
***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as a proof of good faith.

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

AN INSTRUCTIVE ILLUSION.

ON Thursday evening, May 18th, occurred at York one of those smart thunder-showers which followed the break-up over the greater part of England of the sunniest, warmest and driest spring within the memory of most. Hail had fallen, and five minutes later, at 6.50, clear sky appeared among the storm-clouds. Not quite clear, however, for it was flecked with those very delicate, filmy, white clouds which one usually assigns to a very lofty altitude. The sun being within an hour of setting, its slanting rays illuminated these strongly. It was therefore with surprise that I saw shoot athwart these sharply-defined, intensely dark bars of shadow. These evidently came from a portion of cumulus-like thunder-cloud, which topped the main mass just below and to the right of the new moon. Some of the rays sprang direct from its edge, but others at a distance of 2° to 10°. In the shadow the filmy clouds were absolutely invisible, the sky seemingly being of a clear blue, although the shifting of the bars of shadow indicated their actual presence everywhere.



THE STRAIGHT LINE PARTS SUNSHINE & SHADOW.

But the strange question arises, what was the real height of the film-clouds? Must they not, obviously, have been at a lower level than this portion of the thunder-cloud, though higher than the main mass? And yet portions must have been piled higher against the thunder-cloud. Else there could not have been the illuminated space dividing the shadow from the cloud. In some cases the dark bars merged into sheets of shadow, which stretched away 20° or more from the cloud. Apparently, if seen in section, the effect must have been as in the appended sketches.

It is difficult to conceive any other explanation than the above. Hence, either such film-clouds form at lower levels than is generally supposed, or the summits of thunder-clouds penetrate higher than has been supposed.

J. EDMUND CLARK.

WHY NOT THE COLLECTIONS OF SEEDS?

IN these days of stamp, coin, shell, mineral, plant and insect collectors, the writer has often wondered why it is that so few have turned their attention to making collections of seeds. The field, as it appears to me, is one of exceptional interest; exceptional not merely because of the work of real merit that may be done therein, but because it is practically inexhaustible; because the materials are very largely of such a nature as to be cared for with a minimum amount of labor, and require but little space; and because in many instances seeds are themselves objects of great beauty. There are few pursuits in which greater latitude may be allowed, or greater opportunity is given for display of individual energy and mental scope. The amateur, whether man or woman, boy or girl, business man or teacher, cripple or invalid, may each and all collect and find ample room for so much or so little study as he or she may choose to devote to it. One may collect only such seeds as have in

themselves some points of beauty, or are of curious shapes; may know them only by their common or local names, or may take up the subject in a purely scientific spirit, identifying a plant during its flowering stage and finally collecting its seeds when mature, labelling them with both common and scientific names, date of flowering and seeding, and laying away to form a part of what in time may grow to be a collection of real value.

One great objection that may be raised is undoubtedly the difficulty in correctly identifying seeds. There are indeed comparatively few botanists who claim to be able to identify more than a small proportion of the plants they may know, by the seed alone. But this fact only emphasizes the desirability of undertaking just this line of work, and but serves to illustrate the well-known fact that work of real merit may not infrequently be done by the amateur who merely seeks recreation.

GEORGE P. MERRILL.

Washington, Sept. 13, 1893.

SCIENCE IN THE SCHOOLS.

IN a recent article, that well-known scientist, Dr. Groff of Pennsylvania, stated that "it has long been the dream of scientists that the time would come when the elements of natural history and of the physical sciences would be taught in secondary and primary schools." The college professor would, indeed, welcome a greater familiarity on the part of students entering their departments, with the elements of the sciences; but just where this training should begin is not so clear. There is an organized effort being made in some of our leading educational cities to establish this work in not only the secondary schools, but in grammar and primary grades as well. While science should receive a large share of attention in the high schools, and presumably in the grammar grades, is it not going just a little too far to force such work into the *primary* grades? It would certainly appear that, with all the modern innovations already introduced into the primary rooms, sufficient diversion is secured, and certainly, for pure "busy work" the ideal seems to have been reached. Then why crowd these little minds with this additional load, unless it is really superior as a means of education to those studies that are generally acknowledgde so essential as a foundation for subsequent work? Again, I submit that in this early formative period, teaching and encouraging children to capture beautiful butterflies, moths, crickets, or, in fact, any other insects, with the purpose of killing them and picking them to pieces, is not inspiring a regard for God's creatures about them, which sentiment should be instilled into these little people rather than crushed out of existence.

But I think that most agree that *somewhere* in the *grammar* grades the elements of natural history should be imparted. Such, however, is the present crowded condition of the curriculum of our grammar schools that but little, very little, time can be found for it. Nor, indeed, would it be desirable to take much of the pupil's time for such work, in view of the fact that so many studies of more practical importance in life are taught, and rightly, too, in these grades. In our public grammar schools many boys and girls are kept along from year to year at great sacrifices on the part of parents, and they should be allowed to devote their time to such studies as they will most need. It would, therefore, be manifestly unfair to attempt more than the most rudimentary science work in those grades below the high school.

HENRY EDGERTON CHAPIN.

Ohio University, Athens, O.

THE IKONOMATIC METHOD.

IT is strange how difficult it seems for some writers to understand this early, simple and widespread method of recording sounds.

Dr. Thomas in *Science*, Sept. 8, presents a singular instance of this, when commenting on my explanation of the use of the turtle-sign in the glyph for the Maya month-name Kayab. He says: "A compound of *ak* and *yab* cannot be a derivative of *kay*." Of course not! The nature of the ikonomatic theory forbids it; for this has reference not at all to derivation, but to other word or words with solely homophonic, and not etymologic, affinities.

When there are so many examples of ikonomatic hiero-

glyphs presented in a work so accessible and recent as Dr. Antonio Penafiel's "Nombres Geograficos de Mexico; Estudio Jeroglifico," it is scarcely excusable for those who study American archæology either to overlook or to misunderstand this system of writing. D. G. BRINTON.

Media, Pa., Sept. 19.

A CURIOUS EAR OF INDIAN CORN.

A CURIOUS freak of nature was recently discovered in a garden in this city. A stalk of maize or Indian corn failed to develop any ears at the regular places in the axils of the leaves, but instead a single spike of pistillate flowers (an ear) appeared at the end of the central pedicel of the tassel. This ear was about three inches in length, and apparently well formed, except that it lacked glumes. So being exposed to the sun its color was light green. The styles were perfectly developed, and six inches to a foot in length. The places of a few of the grains were occupied by staminate flowers.

Unfortunately this ear was not allowed to grow, and I am unable to say whether it would have developed any perfect grains or not.

Is it a reversion to some ancient form, or only an accidental variation? O. H. HERSHEY.

Freeport, Ill.

A MOUSE DESTROYING ITS YOUNG.

I ONCE had an opportunity of studying a mouse in a cage with a revolving wheel which it was fond of turning, as squirrels are larger but similar wheels. This cage had an apartment over the wheel in which it built a nest from cotton furnished to it. It gave birth to three young mice in the lower apartment, and after a little while removed them to the nest above. One of these young fell out of the nest to the space below. The mother carefully carried it back again. It fell out a second time and was once more replaced. It fell out a third time. The mother then seized it as if angry and unwilling to waste her energies on so troublesome an offspring, and devoured it with no more feeling than if it had been a bit of cheese. M. L. HOLBROOK.

GENEALOGICAL TABLE OF PLANTS.

COULD you or any of the readers of *Science* inform me through your columns where I can find a printed list or table showing the supposed relationships of the commonest genera of plants under the theory of evolution? In other words, I should wish to find a genealogical table of plants from the earliest times to the present day. Has any such work been attempted? THOMAS MARWICK.

New York, Sept. 21, 1893.

NUMBER-FORMS.

NUMBER-FORMS, such as described by Mr. Martin and Mr. Talcott Williams in recent issues of *Science*, were first brought to notice by Mr. Francis Galton in *Nature*, Jan. 15, 1880. In his "Inquiries into Human Faculty" (Macmillan, 1883) there are illustrations of more than fifty varieties of number-forms. A still larger number is given in a recent book by Flournoy (Des Phénomènes de Synopsie, Alcan., 1893). J. MCKEEN CATTELL

Columbia College, N. Y., Sept. 19.

EXCHANGES.

[Free of charge to all, if of satisfactory character. Address N. D. C. Hodges, 874 Broadway, New York.]

For Sale.—A collection of fossil Rhinoceros bones (Apheiops fossiger Cope.) from the Loup Fork Tertiary, including all the bones of one fore and one hind leg, the pelvis, representative vertebræ and ribs, and a nearly complete skull, with complete lower jaws. All the bones of the limbs are perfect. Price $250. Address Dept. of Paleontology, University of Kansas, Lawrence.

For Exchange.—Books and pamphlets on geology, ornithology, conchology, and entomology. State what line and I will send list. I want Odonota from any locality, and literature on this group. M. J. Elrod, Ill. Wes. Univ., Bloomington, Ill.

For a rare chance to get a first-class microscopical outfit write for full particulars to box 125, Sellersville, Bucks Co., Pa.

For sale or exchange.—A fine collection of Lepidoptera, native and exotic. For particulars address Addison Ellsworth, Binghamton, N. Y., care Republican.

For sale or exchange for works on entomostraca, Wolle's "Desmids of the U.S.," Hentz "Spiders of the U.S.," The Amer. Entomologist & Botanist, Vol. 2, The Amer. Entomologist, Vol. 1, Harris's "Insects Injurious to Vegetation," colored plates, copy formerly owned by Townend Glover. C. Dwight Marsh, Ripon, Wis.

"The Conchologist: a Journal of Malacology," Vols. 1 and 2, with wood cuts and plates, value 12/- will exchange for any works or pamphlets on American Slugs or Anatomy of American Fishes. W. E. Collinge, Mason College, Birmingham, England.

Wants.

WANTED.—A recent college graduate to assist in editorial work on Science. Those seeking large emoluments need not apply. N. D. C. Hodges, 874 Broadway, New York.

A GRADUATE in medicine, experienced, will prepare or revise scientific and medical manuscript for publication, read proof, compile bibliographies, &c. Will also consult New York libraries for persons out of town wishing references to rare works. Address M. D., 104 Cambridge Place, Brooklyn, N. Y.

FOR SALE.—Volumes V. and VI. of the "Explorations for a Railroad Route from the Mississippi River to the Pacific," 1857, half calf, in good condition; a large number of colored and uncolored plates of Mammals, Birds, Fish, etc., etc. On receipt of $7.00 will send to any ordinary point in the U. S., express paid. These volumes are now rare. Address Dr. Shufeldt, Takoma Park, Dist. of Columbia.

A YOUNG woman who has been an assistant for a literary and scientific man desires a similar position. Is an experienced and accurate stenographer and typewriter, thoroughly educated, and sufficiently familiar with literary work to write, independent of dictation. Has some knowledge of the Spanish language. Will go to any part of the United States. Address, Box 147, Ravenna, Ohio

A GRADUATE of an American Polytechnic institution and of a German University (Gottingen), seeks a position to teach chemistry in a college or similar institution. Five years' experience in teaching chemistry. Address Chemist, 757 Car y St. Brockton, Mass.

WANTED.—A position as teacher of Biology, by an experienced teacher, a college graduate with four university post-graduate courses in the Sciences. Good endorsements, and eighteen years' experience. Address A. N. Somers, La Porte, Ind.